Green House Guard: Micaz Mote IoT Monitoring System

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Abstract

The wireless sensor network (WSN) is one of the most significant technologies in the 21st century and they are very suitable for distributed data collecting and monitoring in tough environments such as greenhouses. The other most significant technologies in the 21st century is the Internet of Things (IoT) which has rapidly developed covering hundreds of applications in the civil, health, military and agriculture areas. In modern greenhouses, several measurement points are required to trace down the local climate parameters in different parts of a large-scale greenhouse in order to ensure proper operation of the greenhouse automation system. Cabling would make the measurement system expensive, vulnerable and also difficult to relocate once installed. This paper presents a WSN prototype consisting of MicaZ nodes which are used to measure greenhouses' temperature, light, pressure and humidity. Measurement data have been shared with the help of IoT. With this system farmers can control their greenhouse from their mobile phones or computers which have internet connection.

Keywords: wireless sensor networks; internet of things, mica Z sensor nodes, green house

1.Introduction

The most important factors for the quality and productivity of plant growth are temperature, humidity and light. Continuous monitoring of these environmental variables provides valuable information to the grower to better understand, how each factor affects growth and how to maximize crop productiveness1. The optimal greenhouse micro climate adjustment can enable us to improve productivity and to achieve remarkable energysavings especially during the winter in northern countries2. WSN, composed of hundreds of nodes which have ability of sensing, actuation and communicating, has great advantages in terms of high accuracy,

fault tolerance, flexibility, cost, autonomy and robustness compared to wired ones. Moreover, with the onset of IoT and M2M communications, it is poised to become a very significant enabling technology in many sectors, like military, environment, health, home and other commercial areas3. IoT is a general term, covering a number of technologies that allows devices to communicate with each other, with or without human intervention. An example application, presented in this paper, is the Mica Z node-based greenhouse application, which in a timely manner provides a possibility for screen monitoring of detailed data about the conditions of the greenhouse. Furthermore, the suggested setup can be incorporated with other internet and messaging services (i.e. Web, WAP, SMS) to provide communication for farmers.

2.Related Work

In the literature there are numerous examples of versatile IoT application oriented studies. An example of control networks and information networks integration with IoT technology has been studied based on an actual situation of agricultural production. A remote monitoring system with combining internet and wireless communications is proposed. Furthermore, taking into account the system, an additional information management sub-system is designed. The collected data is provided in a form suitable for agricultural research facilities.

In their work Liu Dan et al[5] take a CC2530 chip as the core and present the design and implementation of an Agriculture Greenhouse Environment monitoring system based on Zig Bee connectivity. Additionally, the wireless sensor and control nodes take CC2530F256 as a core to control the environment data. This system comprises front- end data acquisition, data processing, data transmission and data reception. The ambient temperature is real-time processed by the temperature sensor of the terminal node and is send to the intermediate node through a wireless Zig Bee based network. Intermediate node aggregates all data, and then sends the data to the PC through a serial port. At the same time, staff may view, and analyze the data, storage of the data on a PC is also provide. The real-time data is used to control the operation of fans and other temperature control equipment, and achieve automatic temperature control in the greenhouse.

Kun Han et al[6] proposed the design of an embedded system development platform based on GSM communications. Through its application in hydrology monitoring management, the authors discuss issues related to communication reliability and lightning protection, suggest detailed solutions, and also cover the design and realization of middleware software. This hydrology monitoring system based on a wireless communication network is a sophisticated practical application of an embedded system, which includes intelligence, high-efficiency and incorporates hydrology monitoring management services as well.

The studies mentioned above are based on real life solutions but their major strength is the software. In the work presented below, both hardware and software are integrated to produce a wholesome implemented solution for monitoring greenhouse operation.

3.System Description

System architecture

The data of the greenhouse readings are transmitted wirelessly from routing nodes to a central monitoring system (the base station). Depending on the node's distance from the base station, messages can pass through multiple nodes to reach the base station. The base station is connected to a host computer running Mote View to interpret, store and display the collected data. There are three main subsystems involved: wireless network structure, data measurement subsystem and the base station with its graphical interface.

This wireless communication platform uses Mica Z wireless motes programmed in nes C and data transferred to a central database over 802.15.4 based wireless network. The performance of the implemented network was tested based on different network topologies. X Serve serves as the primary gateway between the wireless networks and other applications. At its core, X Serve provides services to route data to and from the mesh network with higher level services to parse, transform and process data as it flows between the mesh and the outside applications.

Wireless Module

The Mica Z off-the-shelf wireless modules are used in this study. Mica Z wireless modules are produced by Crossbow Inc. The Mica Z is a 2.4 GHz, IEEE 802.15.4 compliant, mote module used for enabling low-power wireless sensor networks. The features include: IEEE 802.15.4/ZigBee compliant, 2.4 GHz, a globally compatible ISM band, direct sequence spread spectrum, security (AES-128), 250 kbps data rate, runs Tiny OS 1.1.7 and higher versions.

Software

Tiny OS is an open-source operating system designed for wireless embedded sensor networks. It features a component-based architecture, which enables rapid innovation and implementation while minimizing code size as required by the severe memory constraints inherent in sensor networks. Tiny OS's component library includes network protocols, distributed services, sensor drivers, and data acquisition tools—all of which can be used as-is or be further refined for a custom application. Tiny OS's event-driven execution model enables fine-grained power management and allows the scheduling flexibility made necessary by the unpredictable nature of wireless communication and physical world interfaces. Components have three computational concepts: commands, events, tasks. Commands and events are mechanisms for inter-component communication, while tasks are used to express intra-component concurrency. The wireless modules are programmed with application-specific Tiny OS code using nes C programming language.

The modules comprising the IoT Software subsystem are presented in. Data is collected through sensors on the Mica Z modes. Collected data is processed and transmitted to the MIB 250 Service Support Platform. which is responsible for analysis and operation management. From there the operation is handed down to the Greenhouse Monitoring System module which is responsible for connections to the customer through the Mote View interface or another IoT based Web/Mobile Customer interface. The web application software its self includes three parts of user authentication, data access, data query and download, which access the database through ADO.NET. Thus the remote data acquisition can communicate with the database through ADO.NET. Users have real-time access to data.

4. Test bed setup and experimental results

Test Setup Description

The prototype system described above has been implemented and tested in a real environment.The green parts show the greenhouse area. In Central Monitoring Station, there is a PC connected to MIB520 base station through the USB. The Mica Z motes from Crossbow have read the continuous data stream, extracted the required data and forwarded it through the network to the base station. The measurements are then forwarded to the host PC, and Mote View is used to display the data.

Experimental Results

The modes' placement map and details about the distances between them are given in on the other hand gives the pictures taken from the deployment site greenhouse where the project was tested. Mica Z motes should be placed in the exact locations where measurements should be made. As it can be seen from the pictures some of the nodes are placed on wooden cases higher above the ground, while others are placed directly over the soil. That is where the great advantage of this system being wireless comes into play – it allows great flexibility and can easily be customized according to the specific requirements of each individual farmer. As can be seen from, even if the specific placement of the motes is changed, the designed networking protocol ensures that they will be connected into an operating network, data successfully reach the sink MIB 250 and furthermore transmissions will be made using minimum possible energy. In the measurements taken all nodes were kept constant for each experiment and an example of their connections is given in.

5. Conclusion

In this paper we have presented the results of an IoT based experimental study from the area of agriculture. The designed system allows precise position real time measurements and data transmission from the greenhouse to the interested farmer. Using off-the shelf components (Mica Z nodes) an original routing protocol was designed and incorporated in an IoT based internet accessed agriculture application. All collected data can also be stored on a computer and day/time based reports and graphics are accessible for analysis at any time. The very specific data collection, easily adjustable sensor positions and storage of data allows thorough analysis that can reveal even the most intricate trends in the farming process, thus directing the farmer how to improve the process for the next farming cycle. Furthermore, the long term collected data can be used by agriculture specialists to create more specific timetables and directions for growing specific crops. From the communication point of view, the suggested system provides a one-way flow of information – from the greenhouse to the end user. In our future work we plan to extend the system to include actuators as well, thus providing not only monitoring and data analysis but also precise control for greenhouse farming.

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